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### Neuroradiology

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## COMMENTARY - NEURORADIOLOGY

The application of Diffusion Weighted Imaging (DWI) in the setting of ischemic brain lesions is well established and has now become the standard of care in the MR imaging of patients with strokes and stroke like syndromes. However, most clinicians (and to large extent radiologists) tend to associate DWI with this clinical setting only. DWI and its development Diffusion Tensor Imaging (DTI) are powerful tools that are applied to virtually all aspects of neuroimaging. For this issue I have selected four articles from the American Journal of Neuroradiology that highlight the varied application of these techniques from characterisation of dementias to forensic sciences.

Normal Pressure Hydrocephalus is a difficult diagnosis to make. However, as the symptoms are reversible if CSF drainage is instituted there is a requirement not only to make the diagnosis but also to predict the outcome of shunt placement. Kima et al. suggest that DTI appears to be able to do this with good reliability.

Scheurera et al. report interesting applications of DWI and DTI as a forensic science tool. They suggest that even in the dead brain the ADC values may be helpful in determining the cause of death.

DWI has long been used to differentiate between abscesses and cystic tumours. Toha et al. demonstrate that DTI is also useful in this regard. This ability is particularly useful in our setting due to the relatively high prevalence of abscesses and reluctance of the population to undergo a biopsy.

Demyelinating diseases are debilitating conditions. Until recently it was felt that this Multiple Sclerosis is rare (or even nonexistent) in Pakistan. We now know this not to be true. MS afflicts a significant number of young people in our country. One of the common presentations is with optic neuritis. This is notoriously difficult to image. Smith et al. demonstrate that although DTI is sensitive for optic nerve damage the protocol applied is important.

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## AJNR Am J Neuroradiol. 2011 Sep;32(8):1496-503. Epub 2011 Jun 23

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### DIFFERENTIAL DIAGNOSIS OF IDIOPATHIC NORMAL PRESSURE HYDROCEPHALUS FROM OTHER DEMENTIAS USING DIFFUSION TENSOR IMAGING

**BACKGROUND AND PURPOSE:** Because DTI can provide good markers of white matter pathology, it could be useful in differentiating white matter changes of INPH from those of other dementias. The aim of this study was, by using DTI, to compare the characteristic white matter changes in INPH with those in AD, subcortical vascular dementia, and healthy control subjects. **MATERIALS AND METHODS:** Sixteen patients with presurgical INPH, 10 with AD, 10 with subcortical vascular dementia, and 20 healthy control subjects underwent DTI. All patients with INPH showed clinical improvement after shunt surgery, and 9 of them also underwent postshunting DTI. Regions of interest were selected at the periventricular white matter, the anterior limb of the internal capsule, the posterior limb of the internal capsule, the genu and the splenium of the corpus callosum, the superior longitudinal fasciculus, and the inferior longitudinal fasciculus. FA and MD were obtained from each region of interest and were compared among the groups.

**RESULTS:** Presurgical INPH showed significantly higher FA than all the other groups in the posterior limb of the internal capsule, which was decreased after shunt surgery. Presurgical MD of the INPH group was higher than that in the AD and healthy control groups but lower than that in the subcortical vascular dementia group in the anterior periventricular white matter, the anterior limb of the internal capsule, and the superior longitudinal fasciculus. In differentiating INPH, the sensitivity and specificity of FA in the posterior limb of the internal capsule was 87.5% and 95.0%, respectively. **CONCLUSIONS:** Patients with shunt-responsive INPH showed higher FA in the posterior limb of the internal capsule compared with healthy controls and those in other groups of dementia that was reversible with shunt surgery. With this parameter, shunt-responsive INPH could be distinguished from AD, subcortical vascular dementia, and healthy conditions with high diagnostic accuracy.

## AJNR Am J Neuroradiol. 2011 Sep;32(8):1518-24. Epub 2011 Jun 9

Scheurer E, Lovblad KO, Kreis R, Maier SE, Boesch C, Dirnhofer R, Yen K.

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### FORENSIC APPLICATION OF POSTMORTEM DIFFUSION-WEIGHTED AND DIFFUSION TENSOR MR IMAGING OF THE HUMAN BRAIN IN SITU.

**BACKGROUND AND PURPOSE:** DWI and DTI of the brain have proved to be useful in many neurologic disorders and in traumatic brain injury. This prospective study aimed at the evaluation of the influence of the PMI and the cause of death on the ADC and FA for the application of DWI and DTI in forensic radiology. **MATERIALS AND METHODS:** DWI and DTI of the brain were performed in situ in 20 deceased subjects with mapping of the ADC and FA. Evaluation was per-

formed in different ROIs, and the influence of PMI and cause of death was assessed. **RESULTS:** Post-mortem ADC values of the brain were decreased by 49%-72% compared with healthy living controls. With increasing PMI, ADCs were significantly reduced when considering all ROIs together and, particularly, GM regions (all regions,  $P < .05$ ; GM,  $P < .01$ ), whereas there was no significant effect in WM. Concerning the cause of death, ADCs were significantly



lower in mechanical and hypoxic brain injury than in brains from subjects having died from heart failure (traumatic brain injury,  $P < .005$ ; hypoxia,  $P < .001$ ). Postmortem FA was not significantly different from FA in living persons and showed no significant influence of PMI or cause of death. **CONCLUSIONS:** Performing

postmortem DWI and DTI of the brain in situ can provide valuable information for application in forensic medicine. ADC could be used as an indicator of PMI and could help in the assessment of the cause of death.

## **AJNR Am J Neuroradiol. 2011 Oct;32(9):1646-51. Epub 2011 Aug 11.**

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# **DIFFERENTIATION OF BRAIN ABSCESSSES FROM NECROTIC GLIOBLASTOMAS AND CYSTIC METASTATIC BRAIN TUMORS WITH DIFFUSION TENSOR IMAGING.**

**BACKGROUND AND PURPOSE:** The differentiation of abscesses from glioblastomas and metastases may not always be possible on the basis of DWI. Our hypothesis was that differences in diffusion properties as detected by DTI allow differentiation of abscess from glioblastomas and metastasis. Furthermore, diagnostic performance of tensor metrics quantifying anisotropy or tensor shapes is better than that of ADC in measuring mean diffusivity for this purpose.

**MATERIALS AND METHODS:** DTI was performed in 15 abscesses, 15 necrotic glioblastomas, and 26 cystic metastases. In each lesion, manually segmented into 4 regions of interest (ie, cystic cavity, enhancing rim, and immediate [edema most adjacent to the enhancing rim] and distant zones of edema), FA, ADC, C(l), C(p), and C(s) values were measured and statistically compared among groups and evaluated with ROC curve analysis. The presence of a hyperintense FA rim (a rim of edematous tissue that was hyperintense on

the FA map) was assessed visually.

**RESULTS:** Abscess was significantly different from glioblastoma for all tensor metrics measured in the cystic cavity and immediate zone of edema and for all except C(l) in the enhancing rim. Abscess was significantly different from metastasis for all tensor metrics measured in the cystic cavity and enhancing rim and for FA, ADC, and C(l) in immediate zone of edema. The incidence of a hyperintense FA rim was significantly higher in glioblastoma and metastasis compared with abscess. The 3 tensor metrics with the highest performance in differentiating abscess from glioblastoma and metastasis were FA, C(l), and C(s) of the cystic cavity.

**CONCLUSIONS:** DTI is able to differentiate abscess from glioblastoma and metastasis. FA, C(l), and C(s) outperformed ADC in diagnostic performance comparisons.

## **AJNR Am J Neuroradiol. 2011 Oct;32(9):1662-8. Epub 2011 Jul 28.**

Smith SA, Williams ZR, Ratchford JN, Newsome SD, Farrell SK, Farrell JA, Gifford A, Miller NR, van Zijl PC, Calabresi PA, Reich DS.

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# **DIFFUSION TENSOR IMAGING OF THE OPTIC NERVE IN**

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# MULTIPLE SCLEROSIS: ASSOCIATION WITH RETINAL DAMAGE AND VISUAL DISABILITY.

**BACKGROUND AND PURPOSE:** There is a well-known relationship between MS and damage to the optic nerve, but advanced, quantitative MR imaging methods have not been applied to large cohorts. Our objective was to determine whether a short imaging protocol (< 10 minutes), implemented with standard hardware, could detect abnormal water diffusion in the optic nerves of patients with MS.

**MATERIALS AND METHODS:** We examined water diffusion in human optic nerves via DTI in the largest MS cohort reported to date (104 individuals, including 38 optic nerves previously affected by optic neuritis). We also assessed whether such abnormalities are associated with loss of visual acuity (both high and low contrast) and damage to the retinal nerve fiber layer (assessed via optical coherence tomography).

**RESULTS:** The most abnormal diffusion was found in the optic nerves of patients with SPMS, especially in optic nerves previously affected by optic neuritis (19% drop in FA). DTI abnormalities correlated with both retinal nerve fiber layer thinning (correlation coefficient, 0.41) and loss of visual acuity, particularly at high contrast and in nerves previously affected by optic neuritis (correlation coefficient, 0.54). However, diffusion abnormalities were overall less pronounced than retinal nerve fiber layer thinning.

**CONCLUSIONS:** DTI is sensitive to optic nerve damage in patients with MS, but a short imaging sequence added to standard clinical protocols may not be the most reliable indicator of optic nerve damage.